

# Trees: Novel *In-situ* Groundwater and Soil-vapor Monitors

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# Overview

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- Background phytoforensics
- Comparison to traditional methods
- Case study
- Conclusions

# Mother Nature's Cleanup Crew

Translocation of  
Water and  
Contaminant

Solar Energy  
Drives  
Photosynthesis

## Plants

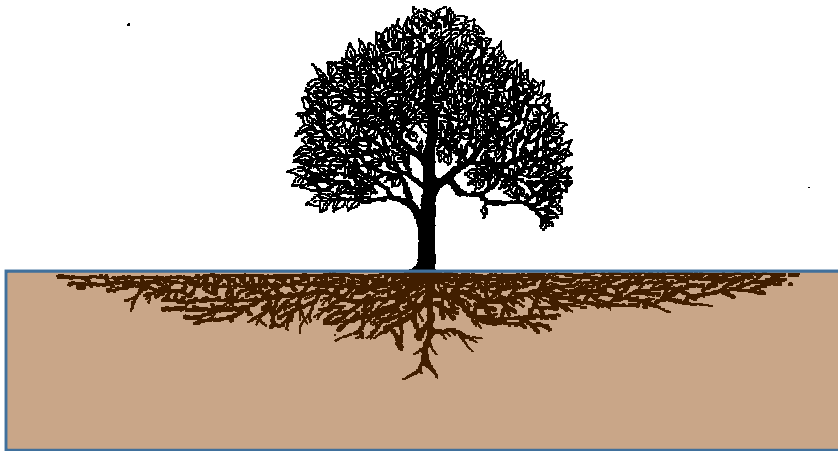
Phytoremediation:

A sustainable  
approach to  
subsurface  
contaminant  
remediation

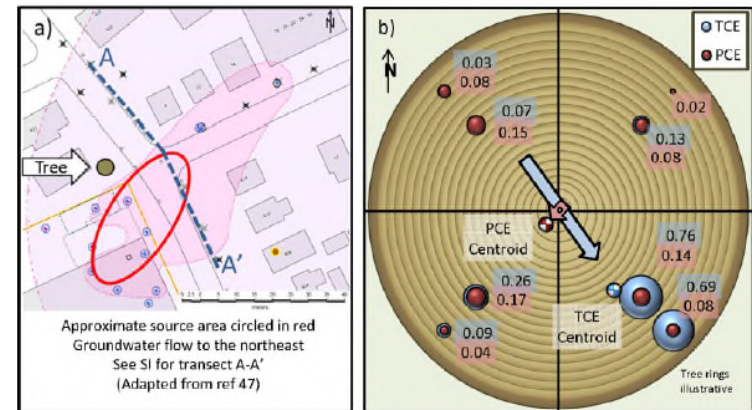
Contaminant Plume

# Sampling Characteristics

## Subsurface Sampling Volume



## Directionality

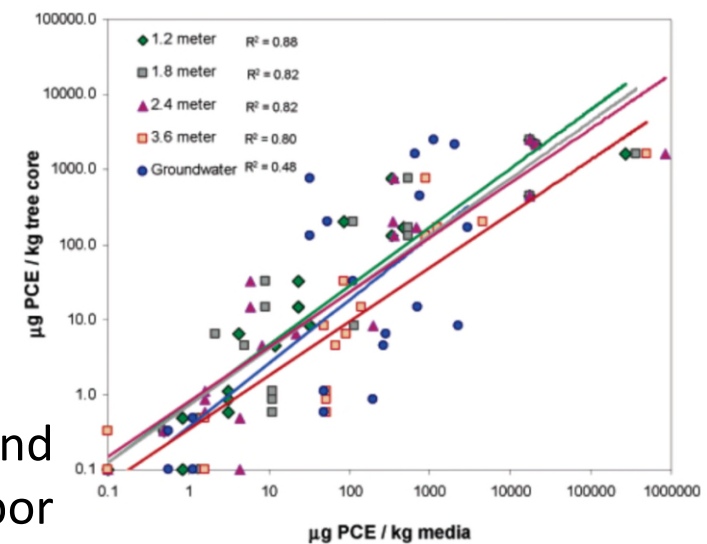


Limmer *et al.*, 2013

## Actively Seek Water



## Uptake Water and Soil Vapor



Struckhoff and Burken, 2005



# Traditional Soil-sample Methods

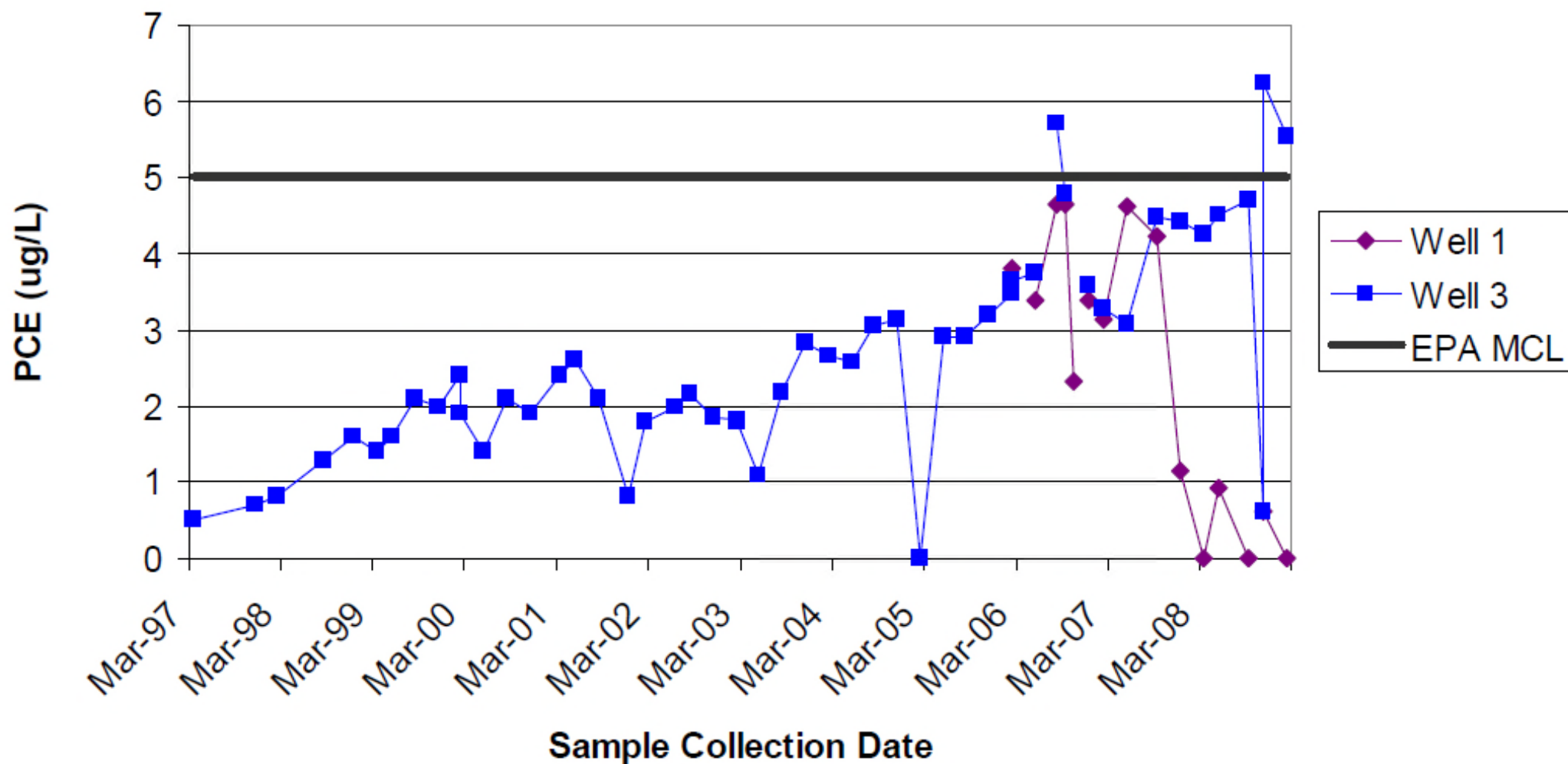








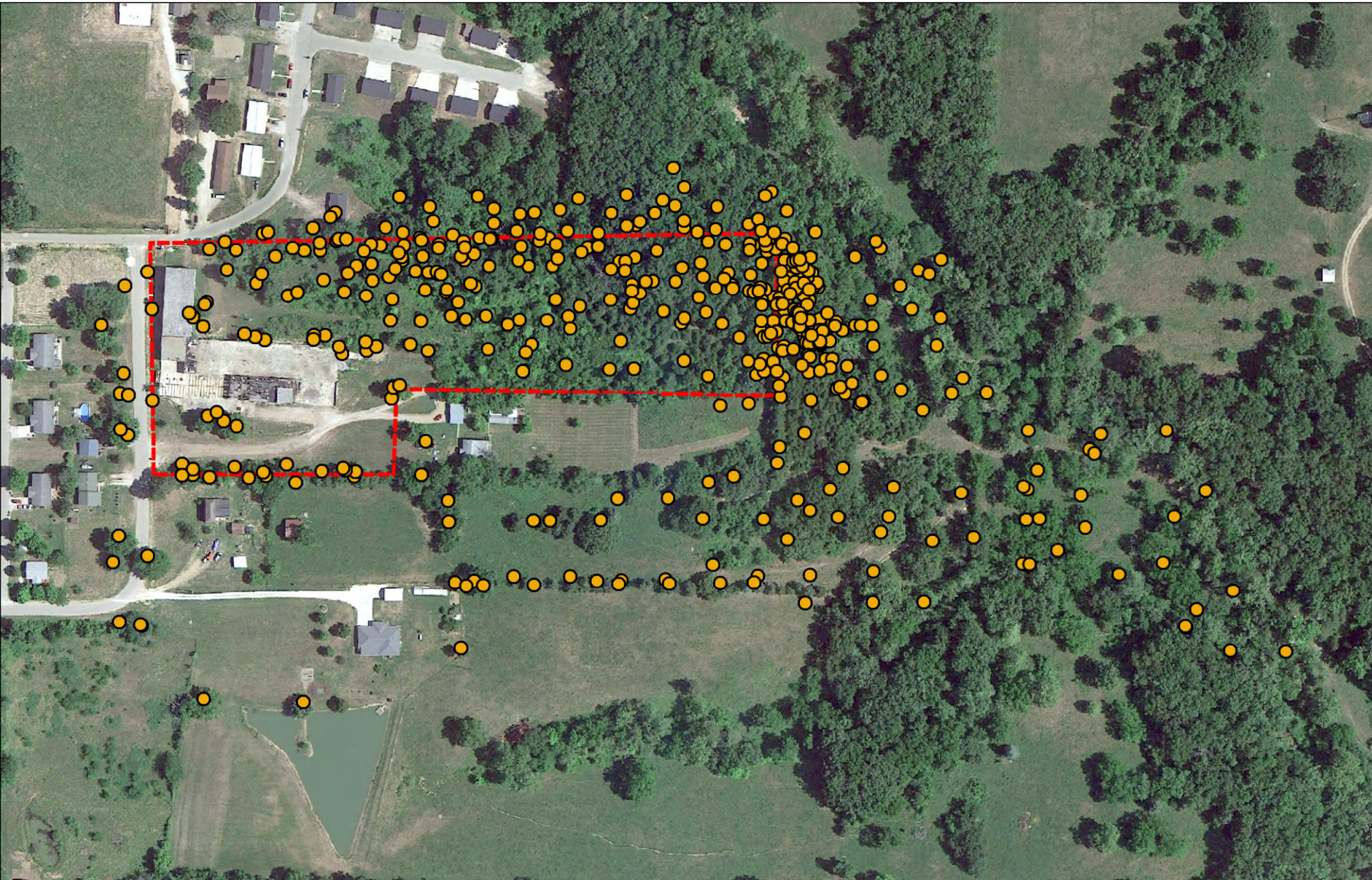
## Concentration of PCE in Vienna Public Drinking Water Wells #1 and #3













# Tree-core Methods

## Sample Collection

- 3-inch tree core collected with incremental auger
- Placed in 20-mL vial with septa-lined cap
- Sampled large/small tree pairs in addition to site-wide screening

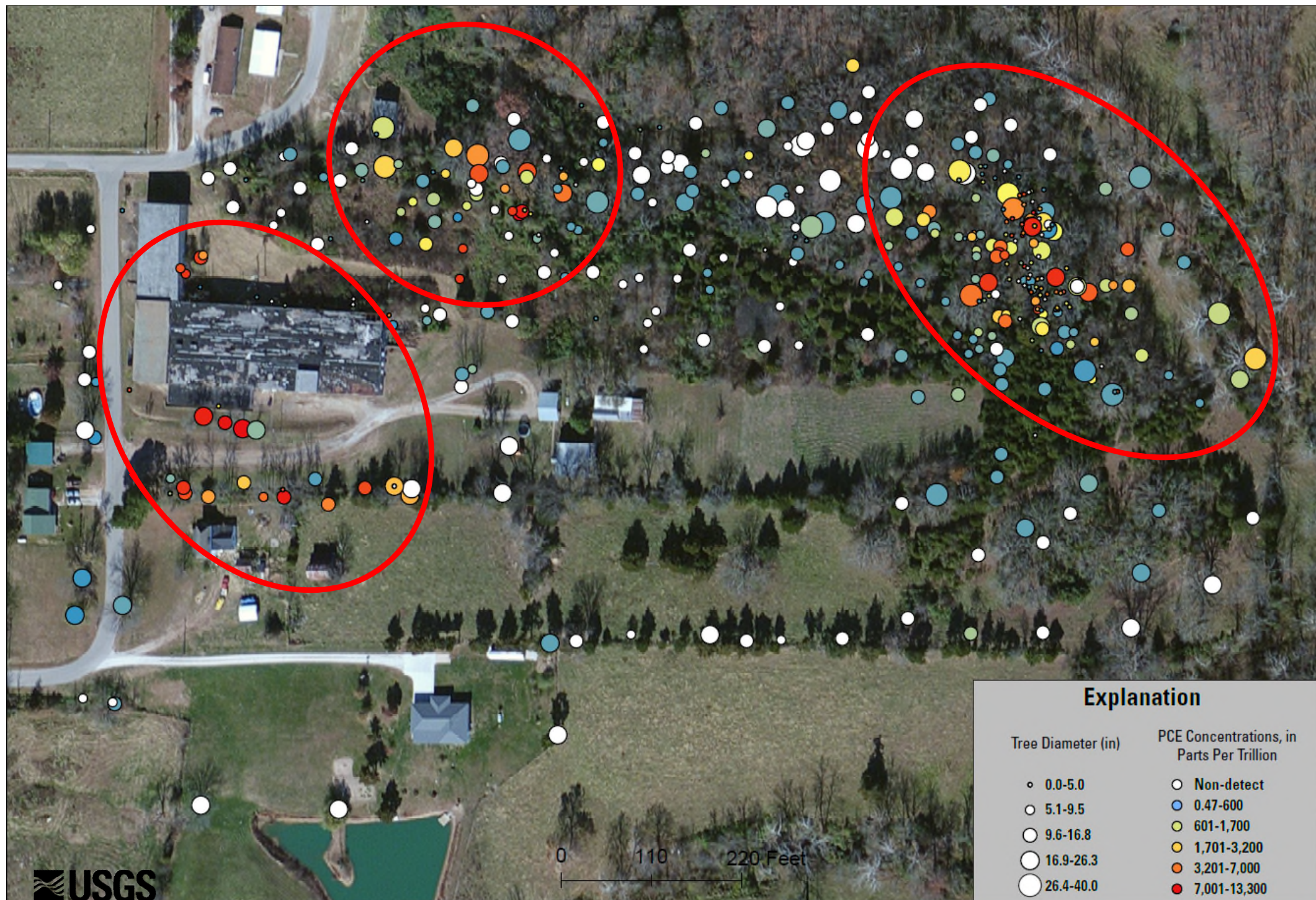


## Sample Analysis

- Vial headspace sampled with portable GC-PID or GC-ECD
- **Reporting limits in single ppt**













# Soil Sampling

## Sample Collection

- Direct-push drilling
- 5-mg sampling extracted from core and mixed with 20 mL of water in vial
- Multiple samples at depth

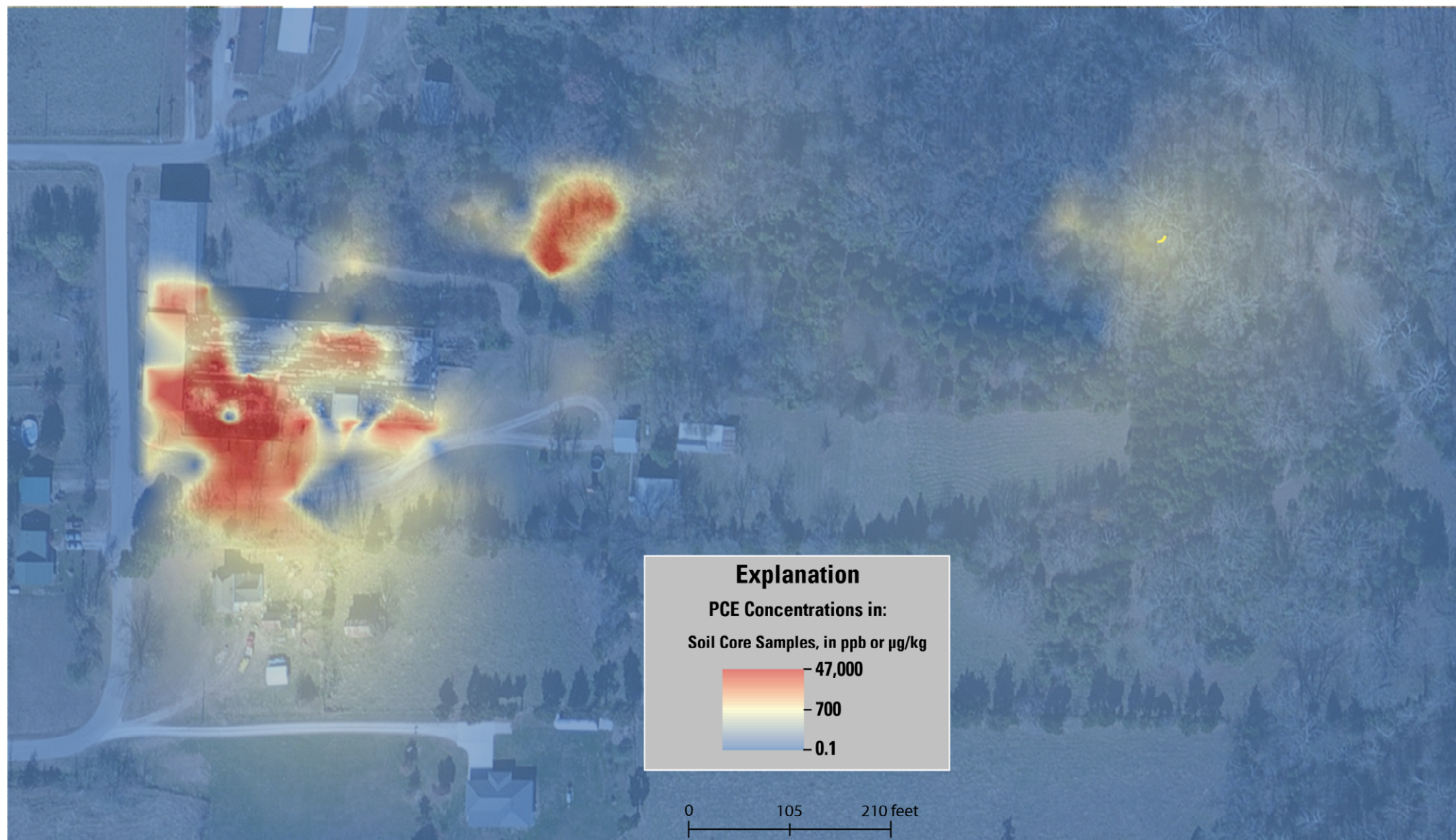


## Sample Analysis

- Vial headspace sampled with portable GC-PID

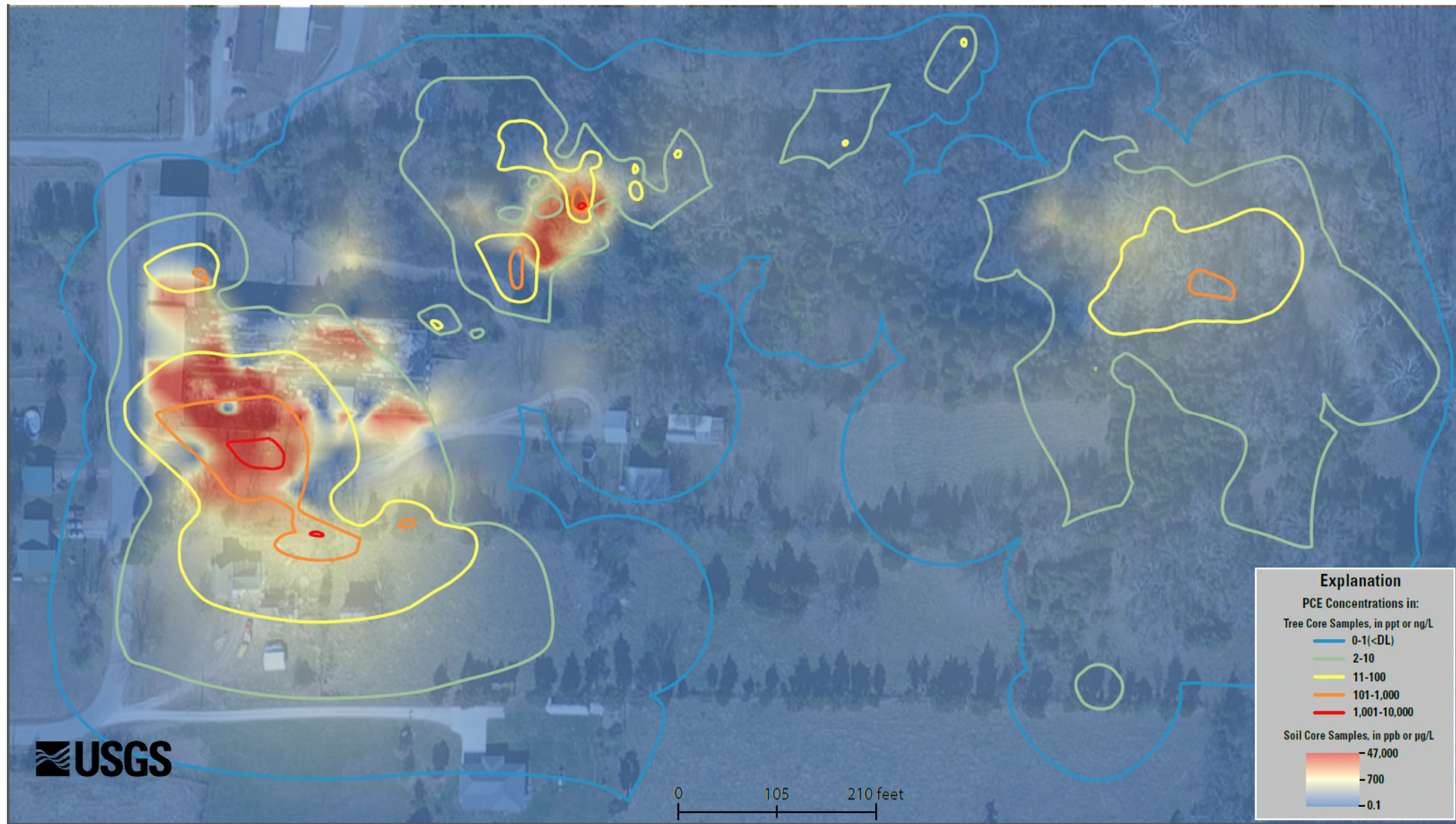


# PCE in Soil Samples





# Soil vs. Tree-core Results

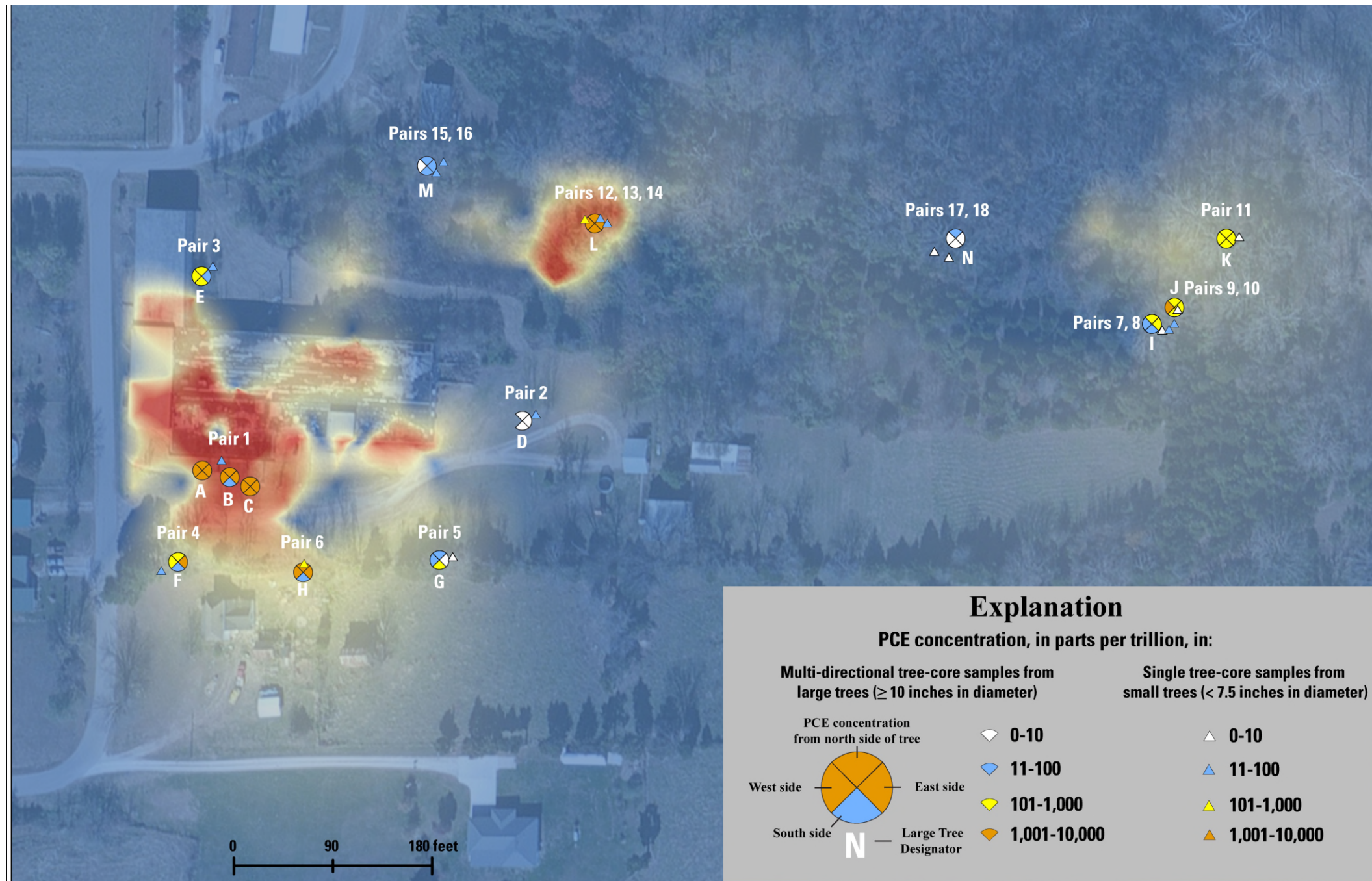




# Paired-tree Study

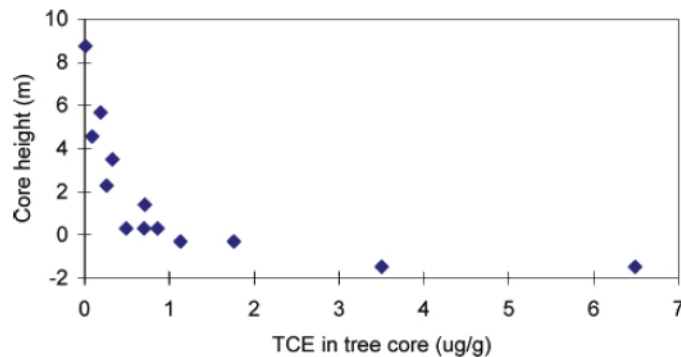
- Paired Study
  - 32 trees samples
  - 14 large diameter ( $\geq 10$  inches) trees
    - Sampled N,E, S, and W
  - 18 small diameter ( $\leq 7.5$  inches) trees







# Accounting for Diffusive Loss

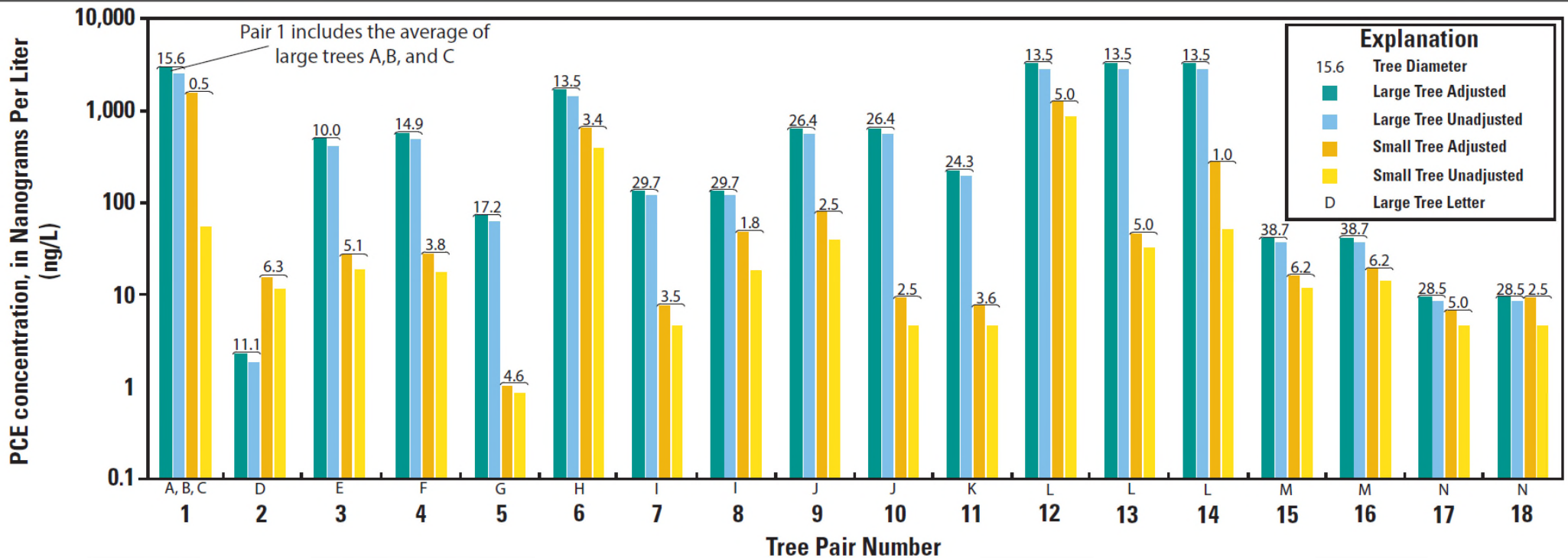


Ma and Burken, 2003

$$C_z = C_o e^{\frac{-kz}{u_c}}$$

Trapp, 2006

$k$  = partitioning coefficient (diameter dependent)  
 $z$  = height above ground  
 $u_c$  = flow velocity





# Size Matters



Contaminant



# Conclusions

- Tree-coring:
  - was five times faster than traditional methods
  - indicated three PCE “hotspots” versus only two indicated by traditional soil sampling
- First measurable concentrations of CFC-113 in trees
- Larger trees likely sample largest subsurface volume compared to smaller trees.



# Questions?

